

Chapter Two: Contents

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Chapter Two—Calibration of River Crossing Screen Lines

1. INTRODUCTION

Rivers in Portland present a barrier to travel that is not explained by the usual discrete choice models. The reduced traffic across these barriers is handled in TRANSIMS by feedback iteration where the number of river crossings is reduced by choosing new activity locations for a portion of the travelers who cross the rivers. Here, two methods to reduce the number of bridge crossings were investigated. Both of these methods make use of the commands in the Activity Regenerator that change the mode coefficient or penalize the travel time for those travelers that make bridge crossings. These methods, while not part of the core TRANSIMS, demonstrate a general methodology using the TRANSIMS technology of changing activity locations to calibrate the model being developed. This generic methodology may be used to change travel characteristics such as the trip length distribution as well as the number of travelers crossing the bridges.

The first method to control river crossings calibrates the number of river crossings by the number of tours that cross the bridges. Because of the technique for counting river crossings and the definition of a work tour used in this method, the calibrated number of trips crossing the rivers was too high. This calibration procedure did, however, show that TRANSIMS technology allows for calibrations of this type. This methodology shows how methods and models are built using the TRANSIMS Framework. Therefore, this technique is described in great detail in Sections 3 and 4 of this document.

A second technique was applied to the results of the first method. In this methodology, the bridge crossings were calibrated to the actual (estimated) trip counts by counting the trips, rather than tours containing trips, crossing the bridges. This final calibration was carried out for just one reason. While a method similar to the one given here would be used in an actual analysis, it was carried for the Portland Study only because it was critical to reduce the amount of traffic on the bridges. Without this reduction in trips, massive traffic jams would occur on the bridges and this would obscure software and network errors that needed to be corrected. See Volume Three (*Feedback Loops*), Chapter Four (*Stabilization*) for more information on both software and network error detection. A short description of the method is given in Section 5 of this chapter.

The river crossing methodologies presented here show that TRANSIMS is not a model. Rather, it is a modeling system. It gives modelers and analysts freedom to develop models and methodologies that mimic established procedures or develop new ones that have not been previously tested. No specific methodologies for travel characteristics, such as the bridge crossings, are “hard coded” into TRANSIMS. The modeler decides what the methodology should be and how to carry it out using the TRANSIMS Framework.

2. THEORY

To reduce the number of vehicles crossing the bridges, new activity locations are selected for a proportion of the synthetic population. Parameters, input to the Activity Regenerator, control the activity locations for these travelers. These parameters are tunable for base year studies and are then used in future year forecasts. In the examples considered here, the use of two parameters, β and c , are studied to determine the best strategy to tune the model. These parameters appear in a choice function:

$$P_L \propto (AT) \text{Exp}(\beta b \max(t + c, 0)^{1/2})$$

where P_L is the probability of choosing destination location L , AT is the attractor value for the destination location and a particular activity type, b is a mode coefficient, and t is the travel time between the origin and the destination location being considered. The value b is obtained via a statistical fit to the survey data. The two parameters, β and c , are the tuning parameters, where β changes the intensity of the mode coefficient and c is a penalty to the travel time.

To study the effect of tuning with β and c , a surrogate for the TRANSIMS choice model was developed. In this surrogate, each of the 1263 traffic analysis zones for Portland was associated with four values: the location of the zone in (x, y) coordinates, an attractor value (AT) that represents a function of the total employment in the zone, a designator to code whether the zone is North of the Columbia River or East/West of the Willamette River, and the total number of workers in the zone. For the examples discussed below, each worker is assumed to work and the travel time (t) between the zones is taken to be the distance between the zones divided by an average speed of 15 meters per second. Intra-zonal travel times are set at 75 seconds. The mode coefficient (b) is -.057, which is the value being used in the Portland study for drive trips to work.

Multiple schemes for calibration using either β or c are given below. In each of these schemes, the initial number of work trips crossing the rivers is determined by the choice model in the following manner. Consider the work location choice for the workers living in zone i . The probability that they choose zone j as the work location is given by

$$P_{i,j}^* = (AT)_j \text{Exp}(bt_{i,j}^{1/2}) / \sum_k P_{i,k}$$

where

$$P_{i,k} = (AT)_k \text{Exp}(bt_{i,k}^{1/2})$$

If W_i is the total number of workers in zone i , then the expected number of work trips that originate in zone i with a destination in zone j is given by

$$W_i P_{i,j}^*$$

The number of trips for each zone pair, (i, j), is computed and the results are summarized by river crossings. In the following table, the river zones are (1) North of the Columbia River, (2) West of the Willamette River, and (3) East of the Willamette River. The total trips are:

	To River Zone 1	To River Zone 2	To River Zone 3
From River Zone 1	49,837	75,919	87,274
From River Zone 2	26,786	255,317	132,020
From River Zone 3	46,983	219,524	259,078

As a proportion of the trips originating in each of the zones, the table becomes

	To River Zone 1	To River Zone 2	To River Zone 3
From River Zone 1	.234	.356	.410
From River Zone 2	.065	.617	.319
From River Zone 3	.089	.418	.493

In most cases the base location choice model produces a higher proportion of river crossings than is seen in reality. The purpose of this paper is to investigate feedback iteration schemes that reduce these river crossings and are usable in a forecast setting.

Four schemes for feedback iteration are considered in this study. In each scheme, the first activity set is generated with β set to 1 and c set to 0. New locations are picked for the tours using either the choice function

$$P_L \propto (AT) \text{Exp}(\beta b \max(t + c, 0)^{1/2})$$

called *coefficient change* or the function

$$P_L \propto (AT) \text{Exp}(\beta^* b \max(t + c^*, 0)^{1/2}),$$

where

$\beta^* = \beta$ if the origin and destinations are in different river zones

$\beta^* = 1$ if the origin and destinations are in the same river zones

and/or

$c^* = c$ if the origin and destinations are in different river zones

$c^* = 0$ if the origin and destinations are in the same river zones

which is called *probability change*.

Values of β and/or c are tried for both functions until the river crossings are matched for the base year.

The new location choices can be applied to only those tours that crossed the river in the original activity set, or they can be applied to all tours. Thus, the four possible calibration methods are:

- 1) *coefficient change* applied to only those tours that cross the river in the original activity set.
- 2) *coefficient change* applied to all tours in the original activity set.
- 3) *probability change* applied to only those tours that cross the river in the original activity set.
- 4) *probability change* applied to all tours in the original activity set.

Each of the four methods can be used changing either β or c or both. Here, we do not consider schemes where both β and c are changed simultaneously.

The results of calibrating using these methods for the North/South crossings are shown in the following two figures. Fig. 1 shows calibration by changing β and Fig. 2 by changing c . The target values are shown in these figures with a horizontal line. Calibration of South/North and East/West river crossings are similar and are not shown.

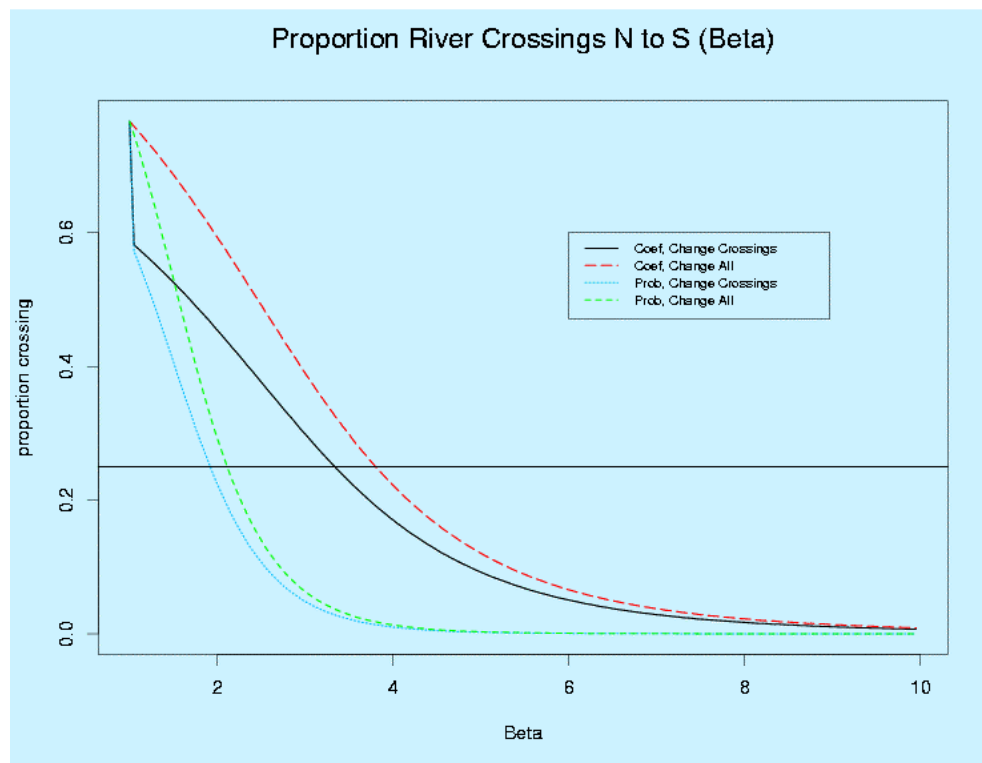


Fig. 1. Proportion river crossings N to S (β).

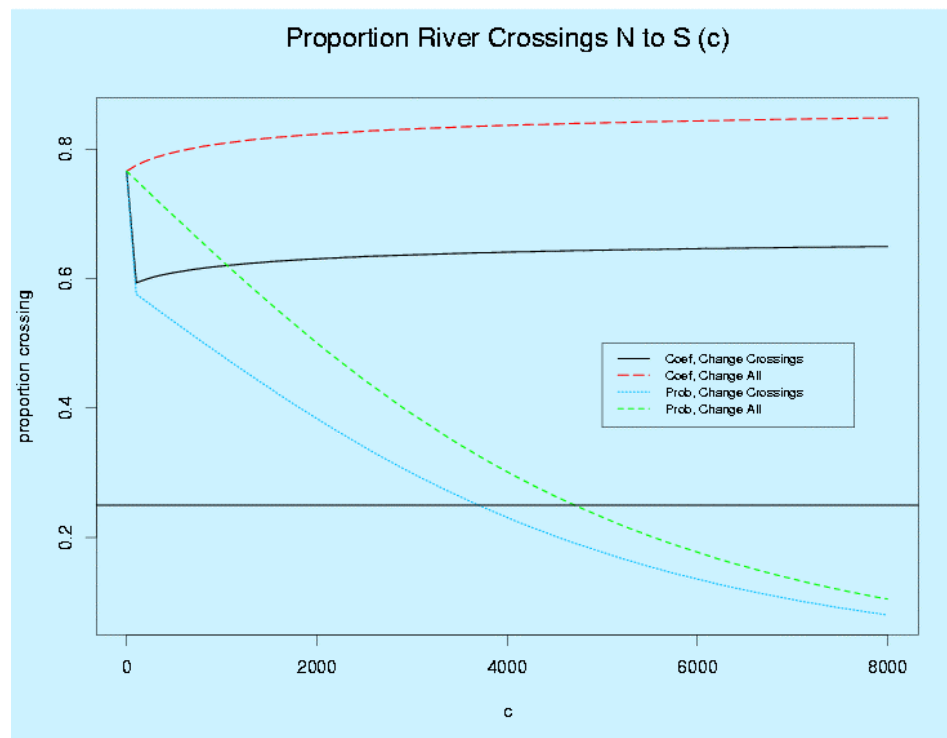


Fig. 2. Proportion river crossings N to S (c).

It is apparent from the above figures that *coefficient change* calibration by changing c will not work. Additionally, all calibration methods where only those tours that cross the river are changed also fail. In each of these cases, there is a spike downward as the values of either β or c are changed even slightly. If this jump overshoots the target value, there is no way to recover. This leaves three possible calibration methods:

- 1) *coefficient change* applied to all tours in the original activity set using β .
- 2) *probability change* applied to all tours in the original activity set using β .
- 3) *probability change* applied to all tours in the original activity set using c .

The method for the Portland study is *probability change* applied to all tours in the original activity set using c .

3. FIRST METHODS FOR PORTLAND RIVER CROSSING CALIBRATIONS

The following are the procedures used in the first method for calibrating river crossings in Portland. This methodology was developed by both Portland Metro and LANL. It attempts to base the bridge crossing calibrations on the number of tours that have at least one round trip that crosses the bridges. It was found that counting the tours rather than the trips crossing bridges and an incorrect definition of work tours that cross the rivers leads to an undercount of the total number of actual trips that cross the bridges. However, the methodology given here is instructive and is shown in detail. It will be helpful to those who endeavor to understand the TRANSIMS technology and to build meta-methods and methods using the technology.

The calibration procedures for this method are not the same for North/South and East/West river crossings. The North/South river crossings across the Columbia River are characterized by different tax structures in the two states and only two bridges across the river. The East/West crossings across the Willamette River are characterized by multiple bridges and are in Oregon.

The North/South crossings are controlled by tour type. Three tour types are considered. In order of importance these are:

- 1) Work (college) tours: Work tours have at least one work activity in these tours. A work tour is considered to cross the river if the home location is on one side of the river and the work location is on the other.
- 2) Shopping tours: Shopping tours do not contain work or college activities, but do have at least one shopping activity. The tour is said to cross the river if any activity, regardless of activity type, requires a river crossing.
- 3) Other tours: Other tours are all tours that do not have work or shopping activities. Any activity on the tour that requires a river crossing causes the tour to be a river crossing tour.

Under this definition, tours where the work and the home are on the same side of the river are not counted as a tour that crosses a bridge even if a trip on the tour does cross a bridge. This and multiple crossings of bridges on the same tour regardless of tour type are the causes of the bridge crossing undercount. While this methodology undercounts the total number of bridge crossings, the ideas presented here will work with minor changes in the way trips are counted. Therefore, as a pedagogical exercise, the procedure used is given in detail.

The activity data set produced by this procedure was refined to correct for the undercount using a second, but related, methodology. This second methodology uses trip counts rather than tour counts to calibrate the river crossings.

Each of the three tours and two directions is calibrated separately starting with work tours, then shopping tours and, finally, other tours. The procedure for each of these tours is given in the following subsections.

3.1 North/South Columbia River Crossings

Identify all tours of the specified type (e.g., work tours with the home North of the Columbia River and the work location in Oregon) from the latest activity set.

- 1) Count the number of river crossings in these tours. Assume here that there are more tours crossing the river than the target value. If this is not true, the algorithm below is searched for a negative value of c

- 2) Choose a value of c to be used in the calibration function:

$$P_L \propto (AT) \text{Exp}(b \max(t + c^*, 0)^{1/2}),$$

where

$c^* = c$ if the trip origin is North of the Columbia River and the destination is South of the Columbia River,

$c^* = 0$ if the origin and destinations are both North of the Columbia River.

- 3) Compute new locations for each of the activities on the tour using the travel time function with c^* added to the travel times and the activity regeneration function that changes all activity locations on the tour from home to home. The parameterized version of the travel time function is to be used. Travel times (t) in the above equation come from the travel time matrix. The value of c^* remains constant regardless of the mode.
- 4) Count the number of tours that cross the river.
- 5) Change the value of c by a binary search. That is, if the number of tours has never been less than the target value, double the value of c and return to step 4. If the number of river crossings is greater than the target value for one value of c , say c_1 , and less than the target value for another value of c , say c_2 , use the average value of c , $c = (c_1 + c_2) / 2$ as the new value of c and return to step 4. If the number of river crossing tours is within 5% of the target value, then exit the loop. The final value of c is retained and used in forecasts.
- 6) Merge the activity set generated in this way with the original activity data set, and calibrate the next tour type starting over at step 1.

3.2 South/North Columbia River Crossings

- 1) The procedure for South/North bridge calibrations is exactly the same as the North/South calibration except that its purpose is only to find the calibration values c . The partial activity sets generated for the South/North tours are not merged with the activity set for the households in the South. Rather, the values of c determined here are used in the East/West calibrations.

- 2) Follow steps 1 to 6 of the North/South calibrations. At the conclusion of these calibrations, retain the calibration values for work (c_w), shop (c_s), and for other tours (c_o).
- 3) The activity data set for those households located South of the Columbia River are determined in the East/West calibration given below.

3.3 West/East and East/West (All South of the Columbia River)

The procedures for the West/East and the East/West crossings are the same. They differ from the North/South calibrations in that the activity set is separated into tour types, but a single calibration value is obtained which applies to all tour types for crossing the Willamette River. Additionally, trips from South/North are penalized by tour type using the values, c_w , c_s and c_o determined in the South/North calibration. The location choice calibration function for the East/West and West/East is:

$$P_L \propto (AT) \text{Exp}(b \max(t + c^*, 0)^{1/2}),$$

where

- $c^* = c$ if the origin and potential destination are on different sides of the Willamette River,
- $c^* = c_w, c_s, c_o$ depending on the tour type and if the trip origin is South of the Columbia River and the destination is North of the Columbia River,
- $c^* = 0$ if the origin and destinations are both on the same side of the Willamette and Columbia Rivers.

The steps in the methodology are:

- 1) Separate the households located on one side of the Willamette River, say the West side, and make an activity set for these households called AS-W.
- 2) Separate the tours in these households into work, shop, and other.
- 3) The travel time function for this calibration is different from the one used for the North/South or South/North calibrations. The calibration constant c is added to the travel times for all West/East bridge crossings. The correct value of c is determined by iteration. In addition to the penalty (c) for the West/East calibrations, the river crossings South/North on these tours are penalized by the constants demanding previously c_w , c_s , and c_o depending on the tour type.
- 4) The iteration scheme to determine c is as follows.
 - Choose a value of c to test.
 - Start with work tours. Using the penalty c_w for the South/North calibrations, determine the number of West/East bridge crossings.
 - Merge the partial activity data set produced by this with the data set AS-W.

- Using the same value of c for the West/East penalty as was used for work and the value c_s to penalize the South/North movements, determine the number of West/East bridge crossings for shopping tours.
 - Merge the partial activity data set produced by this with the data set AS-W.
 - Repeat this process for the other tours using the same value of c and using c_o to penalize the South/North river crossings.
 - Merge this partial activity set with AS-W.
 - Total the number of West/East bridge crossings for the work, shopping, and other tours and compare this value with the target value. A new value of c is chosen depending on this comparison and the above process is repeated.
- 5) Repeat this procedure to determine the calibration constant for the East/West bridge crossings.
- 6) After both the East/West and the West/East calibrations are completed, and after the final activity set is created, the number of tours from the South to the North should be checked. The checks should be made for the individual tour types, work, shop, and other.

4. IMPLEMENTATION AND RESULTS

Several scripts are used to implement the procedures described in Section 2. These scripts are described here and listed in Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*). Results from running the scripts are given in Section 3.8. It should be noted that these scripts are not part of core TRANSIMS software. They are included to demonstrate the use of TRANSIMS technology to build meta-methods and methods for transportation systems.

The scripts invoke programs that typically use a configuration file containing values for parameters that the programs need. The scripts may append additional configuration file keys to the basic configuration file as the iterative procedure progresses. Refer to *allstr_actgen_river_cross.cfg* in Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*) for the basic configuration file used for bridge crossings.

The tour type (described below) is appended to the base name of several of the output files that are produced during the iterative process. One of these files, the log file, notes the progress of the steps in the process and extends across iterations. For example, the name of the log file for North/South work tours is *ActRegenCrossNSW.log*.

4.1 Split the Activity File

The complete activity file is divided into three files based on the home location of the household. The input files for this step are the network activity location file and the activity file after corrections for shared rides and long walks to school have been made (AS-2). One output file contains households with homes North of the Columbia River (river zone 1), another contains the households West of the Willamette River (river zone 2), and the third contains the households East of the Willamette River (river zone 3).

Refer to the Perl script *SplitActByZone.pl* in Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*). The parameters for this script are:

- the network activity location file,
- the activity file (AS-2),
- the output activity file with homes in the North,
- the output activity file with homes in the West, and
- the output activity file with homes in the East.

4.2 Identify Bridge Crossings

A Perl script is used to identify those tours in an iteration database that cross from one river zone to another. This script is invoked by the iteration scripts described in the following sections.

Refer to *FindCrossings.pl* in Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*) for the Perl script described in this section. The required parameters are:

- the iteration database file,
- the output feedback commands file,
- the log file,
- the tour type, described below, and
- 1 or 0 to indicate whether to generate the feedback file.

Each tour is examined to determine the tour type as defined in Section 2, and whether it uses an automobile, includes passengers, and crosses a river. Separate tallies are maintained for automobile tours by type and direction of crossing. An additional group of tallies for the subset of these tours that are shared rides is also maintained, but these tallies are not used in the analysis. The tallies are recorded in the log file.

A file of feedback commands for the Activity Regenerator may also be produced. This file includes a record for all drivers of tours of the specified type and with homes in the river zone of interest. Since this information is independent of whether the tour crosses a river, it need only be produced once for each tour type. The content of each feedback command is

```
<hhid> <activity id> LTR <activity id>
```

4.3 Iteration for North/South Crossings

As described in Section 3.1, an iterative process is used to discover a value of the parameter c in the probability change calibration method that produces the desired number of North/South crossings of the Columbia River for each tour type. A value within 5% of the desired crossings is considered acceptable, and iteration terminates when a value within this range is found. Steps 4.3.1 through 4.3.7 are performed first for work tours, then for shopping tours, and then for other tours.

Refer to the script *FixBridgeCross.NS* in Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*), which implements the iterative process described in this section. The required parameters for the script are:

- the type of tour to be corrected: NSW for work, NSS for shopping, or NSO for other tours,
- the desired number of crossings for this tour type,
- the trial value for c ,
- the activity file (i.e., the file with households in the North produced in step 3.1), and

- the number of processors to use for running the Collator.

4.3.1 Collate the Initial Activity File

The Collator is used to produce an iteration database for the initial activity file. It is run in parallel and produces multiple iteration databases, which are then combined to form a single iteration database containing the tours to be counted. Ten processes were used for this study. The *MakeHouseholdFile* script is used to divide the households into 10 subsets. Ten Collator processes are launched—each operating on one of the 10 household files and producing an iteration database for those households. After each Collator process finishes its portion, the 10 subset databases are concatenated to produce a single database that is the input to the counting step of the process. The name of the initial iteration database for North/South work tours is *itcrossNSW.000.it*.

Use the following configuration file keys in the configuration file for the Collator to produce the required columns in the iteration database:

SEL_USE_END_ACT_LOCATION	1
SEL_USE_END_ACT_TYPE	1
SEL_USE_END_MODE_PREF	1
SEL_USE_END_OTHER_PARTICIPANTS	1
SEL_USE_END_ACT_USER_DATA	River_Zone
SEL_USE_DRIVES_PASSENGER	1

4.3.2 Count Crossings in the Initial Activity File

The number of bridge crossings in the initial iteration database is determined using the *FindCrossings.pl* script described in Section 3.2. The *FindCrossings.pl* script is called by *FixBridgeCross.NS* to count the number of crossings and also to write a file containing Activity Regenerator feedback commands for drivers of tours of the specified type (e.g., drivers of work tours). For example, the file for North/South work tours is named *fbcrossNSW*. The count appears in the log file.

The current crossing count is compared to the desired count, and if the current count is acceptable, no iteration through the Activity Regenerator is required. However, if the initial database contains too many crossings, define $c_{min}=0$ and begin iteration with the trial value for c . If the initial database contains too few crossings, define $c_{max}=0$ and iterate with the trial value for c . (The information in the original activity set corresponds to a value of $c=0$; c_{min} and c_{max} are values of c that bracket the value of c that we are trying to discover.)

4.3.3 Regenerate Activities for Selected Households

The Activity Regenerator is run with the feedback commands produced in step 4.3.2 and the trial value of c . It produces a partial output file containing new activities for the subset of travelers specified by the feedback commands. For example, the partial output for North/South work tours is *cparNSW*. Refer to Volume Seven (*Appendix: Scripts*,

Configuration Files, Special Travel Time Functions) for the travel time function used for North/South crossings.

4.3.4 Collate the Partial Activity File

The Collator is run in parallel with the partial activity file produced by the Activity Regenerator as input. The household files and Collator configuration file keys used in step 4.3.1 are reused. Again, 10 processes were used. After each process finishes its portion, the 10 databases are concatenated to form the next iteration database. For North/South work tours, the database is *itcrossNSW.001.it*.

4.3.5 Count Crossings in the Partial Activity File

The number of bridge crossings in the next iteration database is counted using the *FindCrossings.pl* script. The number of crossings in this iteration is compared to the target number. If an acceptable number of crossings was obtained, iteration terminates and the current value of c is the final value for this type of tour. If the number of crossings is not acceptable, more iterations must be performed.

4.3.6 Continue Iterations Until Acceptable

The first time the *FixBridgeCross.NS* script is run for a particular tour type, it stops after doing steps 4.3.1 through 4.3.5. This allows the user to access how good the first trial value of c was and possibly choose a better guess. By specifying optional script parameters, subsequent iterations may be more automated with several iterations done in a single run. The additional script parameters that permit multiple iterations follow those described in Section 4.3 and are:

- a previous value of c for which the result was above the target, or none if no value is known,
- a previous value of c for which the result was below the target, or none if no value is known,
- the iteration number to begin with, and
- the iteration number with which to end.

The iteration numbers are used in naming the iteration database, so it is important that the iteration numbers are consecutive across multiple iterations.

Iterations that continue the work done in previous iterations repeat steps 4.3.3 through 4.3.5 of the process until an acceptable number of crossings is obtained.

4.3.7 Create a New Activity File

After a value of c that produces an acceptable number of crossings has been determined, the Activity Regenerator partial output that contains the acceptable activities is merged

with the unchanged activities in the initial activity file. The *MergeIndices* and *IndexDefrag* programs are used to do the merging.

4.4 Iteration for South/North Crossings

The process for South/North crossings of the Columbia River is very similar to the process for North/South crossings described in Section 4.3, so all of the details will not be repeated in this section. The differences will be highlighted.

Refer to *FixBridgeCross.SN* in Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*) for the script discussed in this section. The required parameters are:

- the type of tour to be corrected: SNW for work, SNS for shopping, or SNO for other tours,
- the desired number of crossings for this tour type,
- the trial value for c ,
- the activity file (i.e., a file with households in the South), and
- the number of processors to use for running the Collator.

The households West of the Willamette River and those East of the Willamette River compose the households South of the Columbia River. The initial activity file is obtained by concatenating these two files produced in step 4.1.

The *FixBridgeCross.SN* script is identical to the *FixBridgeCross.NS* script until step 3.3.7. The values of c that produce an acceptable number of crossings in the South/North direction for work, shopping, and other tours are retained for use as penalties in the East/West calibrations. The modified activities that produced the acceptable values of c are NOT merged with the initial activities.

4.5 Iteration for West/East Crossings

The procedure for correction of the West/East crossings of the Willamette River differs from the North/South procedure in that a single value of c is determined for correcting all tour types. Tours are still separated by tour type and regenerated and counted separately, but comparison to the desired value of crossings is not performed until the same trial value has been used for all three tour types. For this reason, the comparison to the desired value and automated selection of the next trial value are not present in the script for West/East crossings. Repeat steps 4.5.1 through 4.5.6 below first for work tours, then for shopping tours, and then for other tours using an iteration number of 1 for each tour type.

Refer to the *FixBridgeCross.WE* script in Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*), which implements the iterative process described in this section. The required parameters for the script are:

- the type of tour to be corrected: WEW for work, WES for shopping, or WEO for other tours,
- the penalty for South/North crossings for this tour type produced in step 4.4,
- the trial value for c ,
- the activity file (i.e., the file with households in the West produced in step 3.1),
- the number of processors to use for running the Collator, and
- the iteration number.

4.5.1 Collate the Initial Activity File

This step is identical to 4.3.1.

4.5.2 Count Crossings in the Initial Activity File

The *FindCrossings.pl* script is called by the *FixBridgeCross.WE* script to count the number of crossings and also to write a file containing Activity Regenerator feedback commands for drivers of tours of the specified type (e.g., drivers of work tours).

4.5.3 Regenerate Activities for Selected Households

The Activity Regenerator is run with the feedback commands produced in step 4.5.2, the trial value of c , and the penalty value of c for this type of tour that was obtained in step 4.4. It produces a partial output file containing new activities for the subset of travelers specified by the feedback commands. Refer to Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*) for the travel time function used for West/East crossings.

4.5.4 Collate the Partial Activity File

This step is identical to 4.3.4.

4.5.5 Count Crossings in the Partial Activity File

The number of bridge crossings in the next iteration database is counted using the *FindCrossings.pl* script.

4.5.6 Create a New Activity File

The partial activity file is merged with the initial activity file using the *MergeIndices* and *IndexDefrag* programs.

4.5.7 Continue Iterations Until Acceptable

After steps 4.5.1 through 4.5.6 have been completed for each of the three tour types, the number of crossings of each type is manually summed and compared to the total desired number of crossings in the West/East direction. If the number of crossings is acceptable, no further iterations are required. The activity file produced in step 4.5.6 is the corrected activity file for West/East crossings.

If another iteration is required, begin the procedure again with a new trial value of c . Use the initial activity file, not the activity file at the end of step 4.5.6, as the input activity file. Increase the value of the iteration number parameter by 1. When the iteration number is > 1 , the script proceeds directly to step 4.5.3 because the information generated in the first two steps is already available.

4.6 Iteration for East/West Crossings

The process for East/West crossings of the Willamette River is identical to the process for West/East crossings described in Section 4.5, except that a different travel time function is used. Refer to Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*) for the travel time function used for East/West crossings.

Refer to the *FixBridgeCross.EW* script in Volume Seven (*Appendix: Scripts, Configuration Files, Special Travel Time Functions*), which implements the iterative process. The required parameters for the script are:

- the type of tour to be corrected: EWW for work, EWS for shopping, or EWO for other tours,
- the penalty for South/North crossings for this tour type produced in step 4.4,
- the trial value for c ,
- the activity file (i.e., the file with households in the East produced in step 4.1),
- the number of processors to use for running the Collator, and
- the iteration number.

4.7 Concatenate the Activity Files

The three activity files that contain the corrections for bridge crossings for households in the North, the West, and the East must be manually concatenated to produce a complete activity set for the region. The resulting file is known as *AS-3*.

4.8 Portland Results

The following tables present the results of the iteration procedures that were used with the Portland data. The final value for c in each table is the value of c that produced an acceptable number of crossings.

Table 1. North/South work tours, desired crossings = 58757.

Iteration	C	Crossings
0	0	110003
1	5000	45576
2	3000	67966
3	4000	55876

Table 2. North/South shopping tours, desired crossings = 17761.

Iteration	C	Crossings
0	0	13470
1	-100	17347

Table 3. North/South other tours, desired crossings = 49266.

Iteration	C	Crossings
0	0	22415
1	-300	44561
2	-350	51368

Table 4. South/North work tours, desired crossings = 9897.

Iteration	C	Crossings
0	0	67104
1	5000	13604
2	6000	10476
3	6100	10173

Table 5. South/North shopping tours, desired crossings = 3676.

Iteration	C	Crossings
0	0	12015
1	1000	1775
2	500	3814

Table 6. South/North other tours, desired crossings = 13416.

Iteration	C	Crossings
0	0	18473
1	1000	5149
2	300	10195
3	150	13422

Table 7. West/East all tours, desired crossings = 120000.

Iteration	C	Work	Shop	Other	Crossings
0	0	96434	19656	28836	144926
1	1000	73880	4777	9367	88024
2	300	98847	iteration aborted		67966
3	650	85382	7504	12922	105828

Table 8. East/West all tours, desired crossings = 180000.

Iteration	C	Work	Shop	Other	Crossings
0	0	150910	24079	41419	216408
1	750	138403	7376	iteration aborted	88024
2	250	148574	9655	19003	177232

It is obvious from the tables that, with minor modifications in this methodology, bridge crossing screen lines may be calibrated. The modification is as simple as counting river crossing trips rather than tours. This, however, was not done here because of the constraint of time.

Rather than repeat the process by starting with activity set AS-2 (see Volume One (*Introduction/Overview*), Figure 2 for the flow chart of AS-2 to AS-7) and redoing the methodology to recount trips, a second methodology was developed to change activity set AS-3 to reflect the correct number of bridge crossings. The methodology in this section demonstrates a methodology for these calibrations. The reason in this Study to make the correction to the number of bridge crossings is to understand the stabilization process that is described in Volume Three (*Feedback Loops*), Chapter Four (*Stabilization*) without being swamped with unreasonable traffic across the bridges. This is particularly true for the North/South bridge crossings that had an excess of 25% crossings with only two bridges to handle the traffic. The excess of East/West crossings was smaller and not of concern.

5. A SECOND METHODOLOGY TO REFINE THE BRIDGE CROSSINGS

A second methodology was developed to reduce the number of North/South river crossings. The East/West Willamette River crossings were modeled correctly in the original method. In this correction, the locations of travelers making East/West crossings are only slightly altered. The activity locations of those travelers making North/South crossings are calibrated. The model used is the same one described in Section 4, except that the trips are counted rather than tours

In this method, the population is first divided into the group with home locations North of the Columbia River and those with home locations in the South. Each group is fit to independent travel time penalty coefficients (c). Since the goal is to preserve as many AS-3 activity locations as possible, and an overall reduction in the number of river crossings is desired, all households with no river crossings are removed from consideration.

Because the calculations are all independent, the simplest form of parallelization may be used and many potential coefficients are tested simultaneously. The previous coefficients were near $c=5000$, so twenty values of c —evenly spaced between 0 and 10000—were tested. After counting the crossings in each run, another twenty runs between the two tested values of c that bracket the target number of counts were tested. After this, the value of c that gives the closest number of bridge crossings to the target is selected. This was done simultaneously for both North and South households. (See the *FixBridges.csh* script).

Counting North/South river crossings is done for each test value of c . The auto trips of drivers and the number that had an origin on the North side of the Columbia River and a destination on the South side were counted. Similarly, counts are made for South/North crossings. (See *crossings-driver.awk* and *FixBridges.csh*.)

In developing AS-3, the activity locations, other than the home location, were changed for each trip. Here, as a refinement to AS-3 to obtain a calibrated number of North/South river crossings, not all activity locations were changed. Activity set AS-7 is created by preserving as many AS-3 locations as possible to keep the number of Willamette River crossings and crossings-by-type correct. For the chosen value of c , the households that had a change in the number of Columbia River crossings are determined. For households with no change in North/South crossings, the AS-6 activity locations are used. By doing so, both the number of Willamette River crossings and the relative number of crossings by trip type (work, shopping, or other) are preserved. For the households that did have a change in the number of Columbia River crossings, the new activity locations generated in the testing process are used in AS-7. No effort was made to preserve the number of East/West river crossings or the trip-type distribution in this calibration. Because of the method used, there is, however, little change in either the Willamette River crossings or the trip-type distributions.

This second methodology was developed to correct for the miscalibrated North/South river crossings presented in Section 4. It is obvious from this calibration that, in an actual study, the trips crossing the river could (and should) be the calibration targets rather than the number of tours that make river crossings. It is recommended that the procedures in Section 4 be followed with a change in the way bridge crossings are counted.